

NOTE ON *OPERCULINOIDES* HANZAWA 1935

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ABSTRACT. *Operculinoides* Hanzawa as understood now consists of three distinct groups of forms typically represented by (a) *Nummulites willcoxi* Heilprin, (b) *Operculina ocalana* Cushman, and (c) *O. bermudezi* D. K. Palmer. It is shown that (a) can justifiably come under *Nummulites*, (b) may be regarded as involute *Operculina*, and for (c) there is Caudri's genus *Rauikothalia* which is based on valid grounds.

INTRODUCTION

AFTER a critical examination of *Operculina ocalana* Cushman, *Nummulites willcoxi* Heilprin, *O. floridensis* Heilprin, and *O. mariannensis* Vaughan, Hanzawa considered that they 'show peculiar characteristics intermediate between the typical *Operculina* and *Camerina* or *Assilina*' and proposed the generic name *Operculinoides*, with *N. willcoxi* as the type species, for the above and related forms (Hanzawa 1935, p. 18). Grimsdale and Smout (1949, p. 325) suggested that *Operculinoides* is a synonym of *Nummulites*, but later Smout (1954, p. 76) modified this observation and stated that '*Operculinoides* (Hanzawa 1935) is often taken as complanate and partly involute, but the type species, *O. willcoxi* is a typical Nummulite'.

TABLE

| <i>Genera</i> | | | | | |
|---|--|---|--|---|---|
| <i>Characters</i> | <i>Nummulites</i> | <i>Operculinoides</i> | <i>Operculina</i> | <i>Rauikothalia</i> | <i>Miscellauea</i> * |
| Shape . . . | Lenticular, flat or unevenly globose | Type species evenly low lenticular | Complanate, lenticular in centre only | Evenly low lenticular to nearly flat | Lenticular to nearly flat |
| Form . . . | Involute | Involute mostly, some tending to be evolute | Evolute to partially involute | Involute to partially evolute | Involute; flatter forms tending to be partly evolute |
| Chamber tops as seen in equatorial sections | Acute angle posteriorly | Type species as in <i>Nummulites</i> | As in <i>Nummulites</i> | Bluntly round generally | Bluntly round |
| Whorl wall . . | Single, not differentiated, canaliculate | Type species as in <i>Nummulites</i> | As in <i>Nummulites</i> ; spiral canals tend to be more numerous | Double; inner simple, outer coarsely canaliculate, 'degenerate' | As in <i>Rauikothalia</i> but often more 'degenerate' |
| Whorls . . . | Many, variable | Few to many | Generally few | Generally few | Few to many |

* *Miscellanea* has no marginal cord which is present in all the others.

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There are a number of American forms described under *Operculinoides* which are distinctly 'operculine' while others are as distinctly 'nummulitic'. A solution of the problem can only be arrived at after reconsidering firstly, the characters of the type species of *Operculinoides vis-à-vis* other forms included in this genus and, secondly, the nature of the differences between the forms now included in *Operculinoides vis-à-vis* true *Nummulites* on the one hand and true *Operculina* on the other. A summary of the characters, based on the study of actual specimens as well as published descriptions and figures, of the five genera *Nummulites*, *Operculinoides*, *Operculina*, *Ranikothalia*, and *Miscellanea* as understood now, is given in the table. Another genus, about which there was some confusion, was *Pellatospirella* Hanzawa; but Cole (1956b) has since demonstrated that this genus is not related to any of the above genera but is more allied to *Elphidium*.

DISCUSSION

Nummulites willcoxi Heilprin, the type species of *Operculinoides* Hanzawa, is a low lenticular completely involute form with a clear marginal cord. The septa in equatorial sections are straight for the most part, slightly oblique and sharply curved backwards where they meet the outer whorl wall. The chambers are slightly higher than broad with a clear acute angle formed in the upper posterior end. Apart from a little loose coiling there is nothing in this species which could not suggest placement in the genus *Nummulites*. Other forms included by various authors under the genus *Operculinoides* may conveniently be grouped under (a) *Operculinoides bermudezi* type, or (b) *Operculinoides ocalanus* type. These will be discussed below.

(a) *Operculinoides bermudezi* type.

Sachs (1957) has made a detailed study of *O. bermudezi* (D. K. Palmer) and related forms. As pointed out earlier by Caudri (1944, p. 17), there are two important characters in which this group of forms differs from *N. willcoxi*, viz. (a) the chambers have generally rounded tops and the acute angle formed by the septa on the upper posterior corner of the chambers as seen in *Nummulites* and *Operculina* is usually absent; (b) there is a distinct inner lining on the roofs of the chambers which separates the coarsely canalicate whorl wall above. This latter character is an important one and readily helps in distinguishing this group of forms from typical *Nummulites* and *Operculina*. Cole, who is quite familiar with *O. bermudezi* and related forms, stated: 'American species which were assigned formerly to *Miscellanea* and which are considered here to be *Operculinoides* uniformly possess a coarse marginal cord. At the beginning of this study it was thought that this structure might be of generic significance' (Cole 1953, p. 10). Although, as he states, the marginal cord in *Nummulites* s.l. is extremely variable, forms of the *O. bermudezi* group do exhibit a coarseness in the marginal cord which is not present in any of the true *Nummulites*. According to Vaughan, the American forms of the type *O. bermudezi* 'are intermediate between typical *Miscellanea* and typical *Camerina*' (Vaughan 1945, p. 25). Davies is also of the same view (Davies 1949, p. 113).

The type species of *Ranikothalia* Caudri is *Nummulites nuttalli* Davies. *Operculina sindensis* Davies is a closely related form and, as Davies (1949, p. 113) has pointed out,

there is every gradation from one to the other. However, they can generally be distinguished by the following characters:

| <i>Nummulites nuttalli</i> | <i>Operculina sindensis</i> |
|---|--|
| (a) Whorls gradually increasing in width. | Whorls rapidly increasing in width. |
| (b) Test generally slightly convex. | Test usually flat or most flat. |
| (c) Marginal cord usually strong on the last whorl. | Marginal cord generally strong on all whorls. |
| (d) Megalospheric form lenticular; rather inflated. | Megalospheric form not much different from the microspheric form, though slightly more biconvex. |

EXPLANATION OF PLATE 21

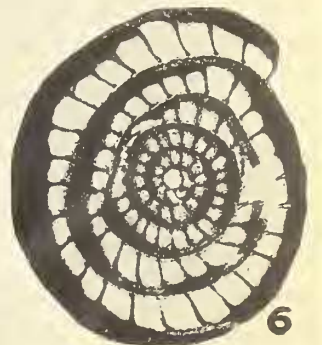
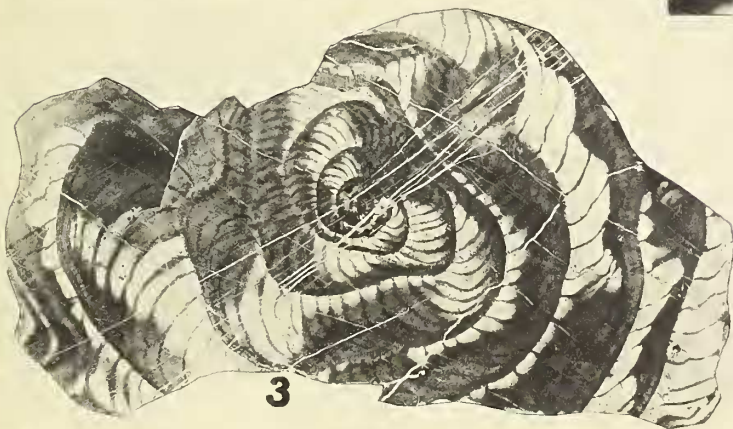
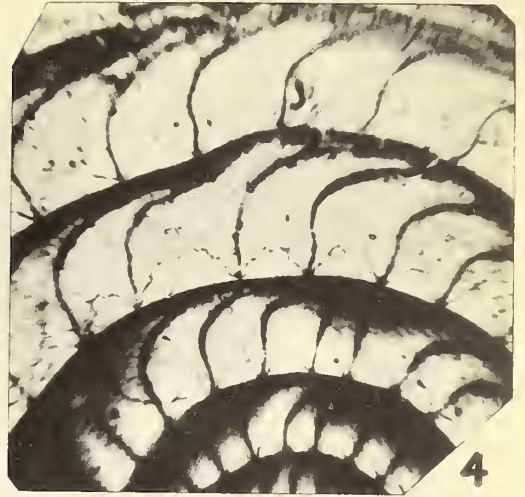
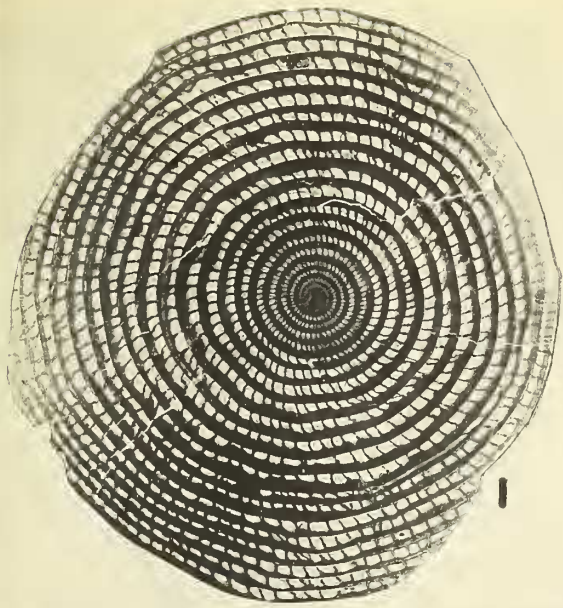
- Fig. 1. *Nummulites beaumonti* d'Archiac and Haime, microspheric form from the Crab Marls (M. Eocene), Bugti, Baluchistan, West Pakistan; equatorial section showing thick whorl wall and nearly straight septa, $\times 5$.
- Fig. 2. *Nummulites pengaronensis* Verbeek, megalospheric form from the Kopili Stage (U. Eocene), Jaintia Hills, Assam; equatorial section showing curved septa, $\times 68$.
- Fig. 3. *Nummulites irregularis* Deshayes, microspheric form from the Tarkhobi Shales (*Irregularis* Bed), L. Eocene, Tarkhobi, West Pakistan; equatorial section showing irregular coiling and delicate, strongly curved septa, $\times 5$.
- Fig. 4. *Nummulites* sp., microspheric form from the Khirthar Shales (L. Eocene), Kirta, Baluchistan, West Pakistan; equatorial section showing delicate, curved septa, $\times 22$.
- Fig. 5. *Nummulites intermedius* d'Archiac, microspheric form from the Nummulitic Limestone (Oligocene), Cutch; equatorial section showing thick whorl-wall and delicate, widely spaced septa, $\times 30$.
- Fig. 6. *Nummulites willcoxi* Heilprin; section showing septa nearly straight, slightly oblique, reproduced from Cole 1953, pl. 1, fig. 12, $\times 12.5$.

EXPLANATION OF PLATE 22

- Fig. 1. *Operculina* sp. from the Upper Chocolate Clays (U. Eocene), Rakhi Nala, West Pakistan; equatorial section showing septa initially straight and normal, sharply curved at the end, $\times 45$.
- Figs. 2, 3. *Operculina* sp. from the Kopili Stage (U. Eocene), Dareng River, Garo Hills, Assam; 2, equatorial section showing delicate and strongly curved septa, $\times 30$; 3, same specimen, portion of whorl-wall $\times 200$ to show canal system (note the numerous spiral canals).
- Figs. 4, 5. *Ranikothalia sindensis* (Davies), equatorial sections; 4, microspheric form from the Zinda Pir Limestone (Palaeocene), Zinda Pir, West Pakistan, $\times 10$; 5, megalospheric form from the Lakadong Stage (Palaeocene), Khasi and Jaintia Hills, Assam, $\times 15$.

EXPLANATION OF PLATE 23

- Fig. 1. *Ranikothalia sindensis* (Davies), equatorial section of megalospheric form from the Khairabad Limestone (Palaeocene), Salt Range, West Pakistan, $\times 15$.
- Figs. 2, 3. *Ranikothalia nuttalli* (Davies), equatorial sections; 2, microspheric form from the Zinda Pir Limestone (Palaeocene), Zinda Pir, West Pakistan, showing wall structure and nature of septa, $\times 4$; 3, megalospheric form from Baluchistan, West Pakistan, showing rounded-top chambers, $\times 15$.
- Fig. 4. *Ranikothalia* sp. from the Brecciated Limestones and Shales (Palaeocene), Tarkhobi, West Pakistan; equatorial section showing double layer of whorl-wall, $\times 68$.
- Figs. 5, 6. *Ranikothalia bermudezi* (D. K. Palmer), equatorial sections; reproduced from Cole 1953, pl. 3, figs. 4 and 12, $\times 20$.
- Figs. 7, 8. *Miscellanea miscella* (d'Archiac and Haime), equatorial sections; 7, megalospheric form, Zinda Pir Limestone (Palaeocene) Zinda Pir, West Pakistan, $\times 10$; 8, microspheric form from the lower part of the Tarkhobi Shales (Palaeocene), Tarkhobi, West Pakistan, $\times 10$.



NAGAPPA, *Nummulites*

